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made during the summer, and again during the winter, to hatch them in aquaria, but without success.

H. W. BRITCHER,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE LARYNX AS AN INSTRUMENT OF MUSIC.

It is with considerable hesitation that I venture to enter into a discussion that has arisen in this Journal under the above title. It is so likely to become a discussion of terms that may be defined by different writers in different ways that it is, perhaps, a question whether a prolonged discussion of the subject is desirable. In spite of this fact, however, I take the liberty of expressing an opinion to which I have been brought by the past several years of observations upon the larynx. Of course, we may call that part of the larynx which vibrates a 'cushion,' a 'reed,' a 'membranous reed,' a 'cord,' a 'membranous cord' or other names, and still find much justification in each case. It seems to me that if we wish to discuss the question as to the class of instruments to which this belongs, we must judge it by two series of facts: first, what elements control the pitch of the fundamental tone produced; second, what is the quality of the tone produced. If we examine the larynx with these points in view, we find, in the first place, that the pitch of the tone produced is controlled by three mechanisms: first, one for increasing tension; second, one for decreasing the length; third, one for lightening the weight of the vibrating part. These three factors are those used for controlling the pitch of a string. If we examine the quality of the tone produced we find that the fundamental and over-tones form a series whose rates of vibration are to each other in the order of the natural numbers, 1, 2, 3, 4; etc., this quality of tone is the quality produced by a string and not the quality produced by a reed or membrane, in both of which the quality is much more complex and contains many intermediate over-tones. It seems to me, in view of these considerations, that we refer to this vibrating part as a 'cord' quite properly. It will be admitted, undoubtedly, by all that the tilting of the cricoid cartilage on the thyroid cartilage in-

creases the tension on the vocal cords, and in so doing raises and tends to control their pitch. The arytenoid cartilages when brought together bring out the edges of the vocal cord from the side of the tube, and by their rotation may decrease the free length of the vocal cords, as is clearly shown by photographs that have been taken of the larynx when producing tones of different pitches. In Fig. 1 we have a section

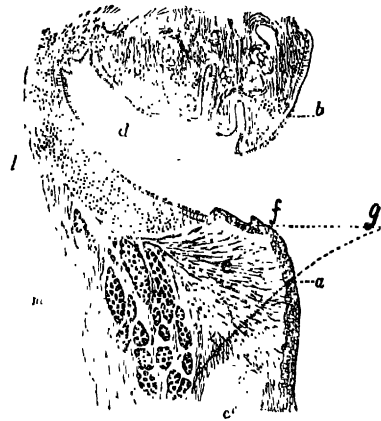


FIG. 1.

through the vocal cord and its immediate surroundings. It is shown in the relaxed position against the wall of the tube. The dotted line between *a...g...f* shows, approximately, the position and form of the cord in action. In Fig. 2 is shown, diagrammatically, a cross-section

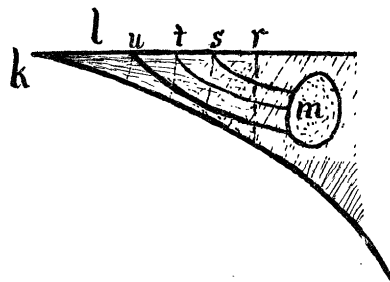


FIG. 2.

tion of the vocal cord, the point extension at *k* being rather exaggerated. *m* is the vocal muscle extending from the inside front of the thyroid to the outer side of the arytenoid, and passing through the back of the vocal cord. This muscle serves to rotate the arytenoid, and

thus shorten the vibrating portion of the cord ; at the same time certain fibers from this muscle extend outward into the cord toward *s*, *t*, *u*, etc. The action of these fibers, when the vocal muscle is contracted, tends to hold rigid more and more of the cord, allowing less and less of the extreme edge to vibrate. This action lessens the weight of the vibrating part of the cord.

Other minor facts tend to confirm the belief that the action is essentially that of a cord. For example, the extreme edge, as indicated at *k*, is of a different material from the rest of the cord and the whole structure of the cord is entirely different from that of the lips, or from what could be properly defined as a cushion. In observations upon the vocal cords when producing a tone it is very often easy to recognize certain secondary nodal points in the cord. If a little mucus happens to be upon the vocal cord at the time of producing a continued tone, the mucus collects at the secondary nodal points, just as sand upon a vibrating plate, and is easily apparent as a white spot upon the edge of the cord.

Of course, in those cases where the larynx has been removed and an artificial voice apparatus has been introduced, the source of sound has been a reed, but this has been simply from a mechanical difficulty of introducing a vibrating string which should have the proper range. The reed is extremely simple mechanically and answers the purpose quite satisfactorily. But this offers no argument in support of the belief that we are dealing with a reed instrument in the human voice. It is true that Helmholtz and others have referred to the larynx as a reed instrument, but it is curious to note that after this reference has been made, Helmholtz continues in the most elaborate way to treat the quality of the sound produced by the human voice as if it had been produced by a vibrating string, discussing the pitches and intensities of the over-tones of a string and never referring to other over-tones of a reed or a membrane.

It is claimed that the vibrations of the air in the mouth cavity are 'free vibrations' and not 'forced' ones and that these free vibrations in the mouth cavity are excited by the impulses from the larynx formed by the explosive open-

ings between the vocal cords. In this connection Professor Scripture, in his contribution from the Yale Psychological Laboratory, describes an experiment of making a key whistle by blowing in its end a stream of air, which has been rendered intermittent by artificial vocal cords. No one denies for a moment that impulses or a succession of impulses may set up the natural vibrations of a resonance cavity, but it must also be borne in mind that a continuous stream of air under the same circumstances will produce a more forcible result just in proportion as the energy in the continuous stream is greater than in the interrupted stream. Thus, we know that a continuous current will cause a key to whistle, and there is no mechanical reason why an interrupted current should not produce a similar result while the puffs last. Applying this to the mouth cavity as related to speech, we have a natural vibration set up in the case of a whisper by the continuous current of air rushing through these cavities. Interruptions in this current will not increase the intensity of the natural vibrations of the air in the cavities. We have precisely an analogous case if we simply blow through a clarinet or cornet or flute without establishing the primal source of sound by the vibration of the reed, the lip, or the air jet.

It seems to me that, fundamentally, there can be no difference between a vowel as sung and that same vowel as spoken. Of course, the duration of the vowel sound may be very short, but during that period it must have its perfectly definite quality in order to be recognized, and it seems incorrect to assume one set of determining factors in case of a spoken vowel and another set in the case of the vowel as sung. The problems involved in this discussion, overlapping the subjects of anatomy, physiology and mechanics, are naturally very troublesome, and it is readily to be expected that the physicist is perhaps inclined to lay too much stress upon the mechanics of air vibrations. But on the other hand, the physiologist and the students of phonetics have in too many cases brushed aside serious mechanical obstacles with a nonchalance that is scarcely justified by the facts. In those cases where the synthesis of the vowel

sounds has been most satisfactory they have been made up of the fundamental and *string* over-tones and not by the combination of the pitch tone with a 'characteristic pitch' having no harmonic relations between the two. In the case of spoken vowels it seems to me of fundamental importance that the individual should speak upon a known pitch, otherwise the case is hopelessly confused by a constantly changing fundamental. In a great many of the investigations involving the so-called characteristic pitch of the different vocal sounds, it seems uncertain as to whether or not this so-called 'characteristic pitch' may not be more directly due to some inherent rate in the apparatus itself, rather than in the sound which it is supposed to record impartially. In this connection it must be borne in mind that the widest possible variations in tone quality are still recognized as the same vowel spoken by different individuals under different conditions. This discussion has wandered from the musical instrument to the articulator. In music the vowel is everything, the consonant usually inconspicuous; in speech the vowel is secondary and the consonants all-important.

WILLIAM HALLOCK.

PHYSICAL LABORATORY,
COLUMBIA UNIVERSITY, June, 1901.

'IS LARVÆ CONTAGIOUS?'

THE following cross interrogatories were prepared by the district attorney of a county in a western State for a deposition.

What is larvæ? What does larvæ come from? Is larvæ injurious to fruit trees? Is it contagious?

What is pupæ? Describe it fully? Is it injurious to fruit trees? Is it contagious?

It seems to me that the questions furnish an answer to the frequent question in the scientific laboratory, 'Will this ever be of any use to me?' If such knowledge furnish nothing else to a man, it would prevent him from making such questions as these.

H. S. GAUS.

CURRENT NOTES ON PHYSIOGRAPHY.

GLACIAL CORRIES IN THE BIGHORN MOUNTAINS.

THE glaciated district near Cloud Peak, Bighorn Mountains, at altitudes above 10,000 feet,

contains over forty corries or cirques of more or less pronounced form, as mapped and described by Matthes ('Glacial Sculpture of the Bighorn Mountains, Wyoming,' 21st Ann. Rep. U. S. Geol. Surv., 1900, pt. II., 167-190). A contour map shows the summit of the range in general with rounded forms free from sharp peaks and precipitous cliffs. The valleys on the slopes below 10,000 are usually broadly open; but on ascending towards the stream sources, the valley walls steepen on either side of a broad floor where rock basins hold many little lakes, and at or near the valley head the walls close in a great cliffed amphitheater. Highland streams cascade down from shallow hanging valleys into the deep cirques. It is concluded that these peculiar forms are here, as elsewhere, to be regarded as glacial modifications of preexistent valleys that once had more ordinary form. In a few cases, the widening and headward recession of the valley walls have resulted in the consumption of the rounded uplands of the mountains so far that only a narrow, sharp, serrate wall remains; this is well seen around Cloud Peak, thus giving support to Richter's views regarding the importance of glacial action in producing sharp peaks and arrêtes in the Alps. In a single remarkable example, an east-sloping valley (No. 20) receives the drainage of the uppermost mile of a southwest-sloping valley (No. 18) in such a way as to suggest very strongly the glacial capture of the latter by the former; and this is made the more probable when it is noted that the capturing valley has a distinctly stronger slope than the captured. If it be admitted that glacial erosion has made significant changes in the valley forms—and this does not seem to be open to dispute—the present pattern of drainage in these two valleys could not have existed in preglacial time.

It is a curious commentary on the education of our topographers that articles of the kind here referred to should be so rare.

THE NORTH GERMAN LOWLAND.

THE accounts of the North German lowland as a region of glacial topography by Berendt, Wahnschaffe, Keilhack and others are supplemented to an extraordinary degree of detail by